CBRN Air – Purifying Escape Respirator Conceptual Requirements

Hazard Analysis and Selection

Initial vulnerability assessment list of chemical agent hazards identified potential respiratory hazards

- **Classification of hazards into Agent Families**
- **Test Representative Agent (TRA) required for each family of agents.**
- **Back up data with other agents within family being generated.**
- **Biological and Radiological agents are addressed as particulates requiring P-100 media**

Testing of the TRA should provide protection for respirable Chemical agents (110), plus Particulate Biological agents (13) & Particulate Radiological/Nuclear agents (16):

61 Organic Vapor Family, with vapor pressures less than that of Cyclohexane (TRA)

32 Acid Gas Family, TRA's = Cyanogen Chloride, Phosgene, Hydrogen Cyanide, Hydrogen Sulfide, and Sulfur Dioxide

4 Base Gas Family, TRA = Ammonia

5 Nitrogen Oxide Family, TRA = Nitrogen Dioxide

4 Hydride Family, TRA = Phosphine

1 Formaldehyde Family, only member of family and TRA

32 Particulate Family, TRA = dioctyl phthalate (DOP)

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Particulate Biological Agents
(USAMRIID and/or CDC Lists)

- **Anthrax**
- **Brucellosis**
- **Glanders**
- **Pneumonic Plague**
- **Tularemia**
- **Q Fever**
- **Smallpox**
- **Venezuelan Equine Encephalitis**
- **Viral Hemorrhagic Fevers**
- **T-2 Mycotoxins**
- **Botulism**
- **Ricin**
- **Staphylococcus Enterotoxin B**

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Particulate Radiological\Nuclear Agents

(USAMRIID and/or DOE Lists)

- **Hydrogen 3**
- **Carbon 14**
- **Phosphorous 32**
- **Cobalt 60**
- **Nickel 63**
- **Strontium 90**
- **Technetium 99m**
- **Iodine 131**
- **Cesium 137**
- **Promethium 147**
- **Thallium 204**
- **Radium 226**
- **Thorium 232**
- **Uranium 235 & 238**
- **Plutonium 239**
- **Americium 241**

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CBRN Escape Respirator Concepts

- Benchmark Testing
- State of Art Existing Designs
  - Gas Capacity (Service Time)
  - Live Agent Testing
  - Breathing Gas CO_2 & O_2

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Gas Life Concepts – LOW Category

	Test Challenge	Breakthrough
Ammonia	1250	150
Cyanogen Chloride	150	0.4
Cyclohexane	1300	10
Formaldehyde	250	10
Hydrogen Cyanide	470	10 (sum of HCN + C2N2)
Hydrogen Sulfide	500	30
Nitrogen Dioxide	100	1 ppm NO_2;
Phosgene	125	0.2
Phosphine	150	0.5
Sulfur Dioxide	750	3

Breakthroughs based on Emergency Response Planning Guidelines

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Gas Life Concepts – SPECIFIC Category

	Test Concentration (ppm) Draft	Breakthrough Concentration (ppm) Draft
Cyclohexane	2600	10
Phosgene	250	0.2
Cyanogen Chloride	300.	0.4
Hydrogen Cyanide	940	10

- Additional specific test agent protections can be added to the minimum as specified by the applicant for: Ammonia, Formaldehyde, Nitrogen Dioxide, Hydrogen Cyanide, Sulfur Dioxide, Phosphine, and Carbon Monoxide.

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Gas Capacity (Service Time) Benchmark Testing

CBRN 10 Test Agents

Inadequate Capacity:

ammonia, nitrogen dioxide

Adequate Capacity

cyclohexane, sulfur dioxide, formaldehyde, hydrogen sulfide, cyanogen chloride, phosphine, phosgene, hydrogen cyanide.

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CBRN Escape Respirator Benchmark testing (Type A)

		Challenge Conc.	End Pt Conc.			
Flow/Humidity				64/25	64/80	100/50
Cyclohexane	C6H12	1300	10	37.6	26.9	21
Sulfur Dioxide	SO2	750	5	29.9	38.9	18.4
Ammonia	NH3	1250	12.5	2.4	2.6	1.4
Formaldehyde	CH2O	250	1	22.0	17.7	6.7
Hydrogen Sulfide	H2S	500	5	120.0	120.0	77.8
Cyanogen Chloride	CK	150	2	120.0	120.0	86.5
Phosphine	PH3	150	0.3	120.0	120.0	108.7
Phosgene	COCl2	125	1.25	120.0	120.0	120.0
Nitrogen Dioxide	NO2	100	25/1*	11.3	37.0	7.8
Hydrogen Cyanide	HCN	470	5**	120.0	120.0	81.9

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CBRN Escape Respirator Benchmark testing (Type B)

		Challenge Conc.	End Pt Conc.			
Flow/Humidity				64/25	64/80	100/50
Cyclohexane	C6H12	1300	10	66.9	56.1	42.8
Sulfur Dioxide	SO2	750	5	51.4	82.8	38.0
Ammonia	NH3	1250	12.5	8.0	8.3	4.5
Formaldehyde	CH2O	250	1	48.9	47.0	21.8
Hydrogen Sulfide	H2S	500	5	120.0	120.0	120.0
Cyanogen Chloride	CK	150	2	120.0	120.0	120.0
Phosphine	PH3	150	0.3	120.0	120.0	120.0
Phosgene	COCl2	125	1.25	120.0	120.0	120.0
Nitrogen Dioxide	NO2	100	25/1*	21.6	41.2	11.2
Hydrogen Cyanide	HCN	470	5**	120.0	120.0	120.0

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CBRN Escape Respirator Benchmark testing (Type C)

		Challenge Conc.	End Pt Conc.			
Flow/Humidity				64/25	64/80	100/50
Cyclohexane	C6H12	1300	10	26.8	17.7	13.3
Sulfur Dioxide	SO2	750	5	17.8	24.6	9.7
Ammonia	NH3	1250	12.5	16.0	19.2	9.4
Formaldehyde	CH2O	250	1	52.9	32.9	16.6
Hydrogen Sulfide	H2S	500	5			
Cyanogen Chloride	CK	150	2			
Phosphine	PH3	150	0.3			
Phosgene	COCl2	125	1.25			
Nitrogen Dioxide	NO2	100	25/1*			
Hydrogen Cyanide	HCN	470	5**			

CBRN Escape Respirator Benchmark testing (Type D)

		Challenge Conc.	End Pt Conc.			
Flow/Humidity				64/25	64/80	100/50
Cyclohexane	C6H12	1300	10	38.3	28.9	21.2
Sulfur Dioxide	SO2	750	5	23.5	35.8	15.7
Ammonia	NH3	1250	12.5	6.3	6.8	3.1
Formaldehyde	CH2O	250	1	30.5	20.2	10.1
Hydrogen Sulfide	H2S	500	5	112.1	120.0	69.9
Cyanogen Chloride	CK	150	2	120.0	120.0	85.9
Phosphine	PH3	150	0.3	120.0	120.0	120.0
Phosgene	COCl2	125	1.25	120.0	120.0	120.0
Nitrogen Dioxide	NO2	100	25/1*	10.3	15.3	3.8
Hydrogen Cyanide	HCN	470	5**	120.0	120.0	77.4

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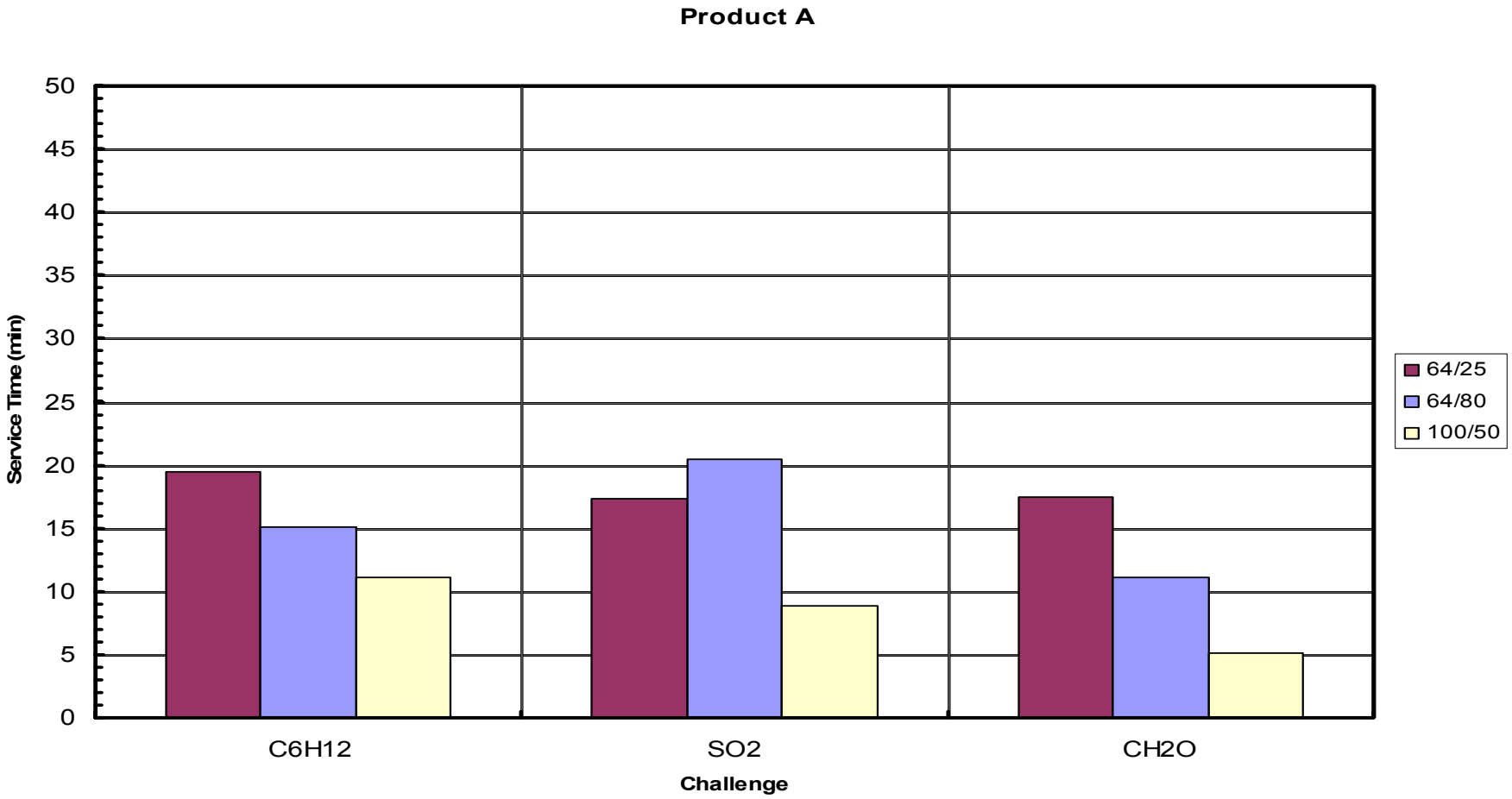
Benchmark Testing – High Concentrations



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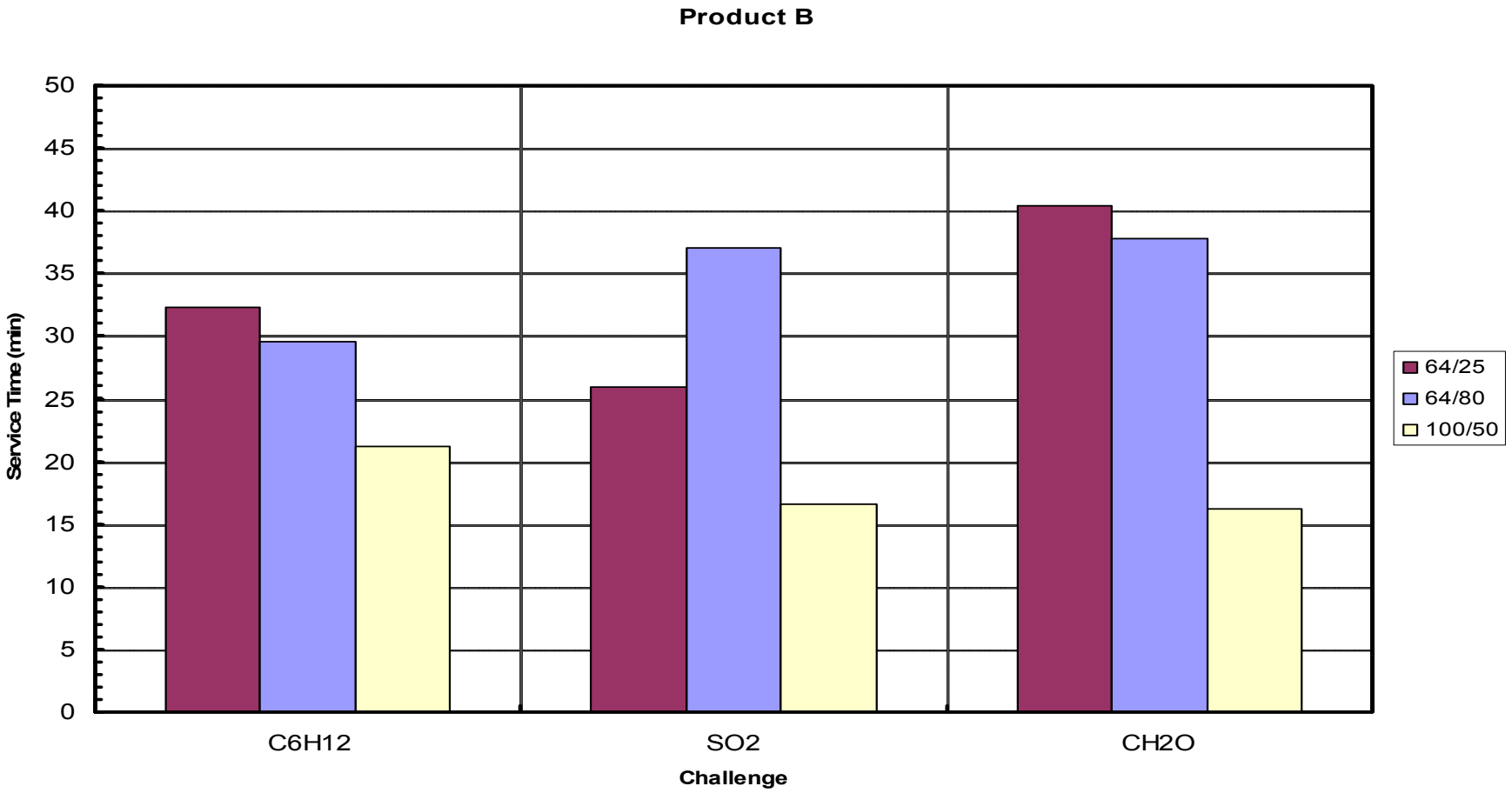
Benchmark Testing – High Concentrations



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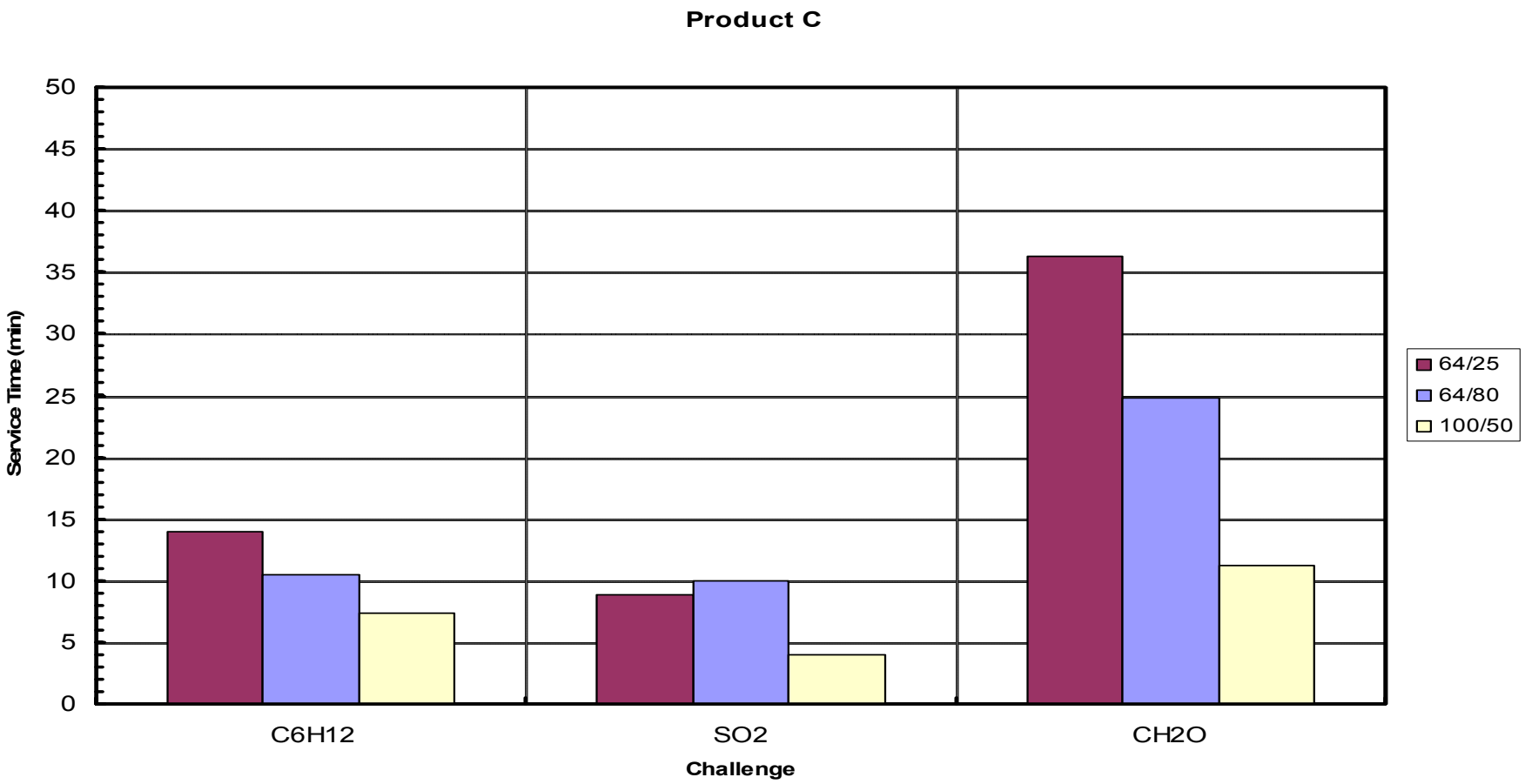
Benchmark Testing – High Concentrations



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Panic Demand

Each escape respirator shall provide a minimum service life of 5 minutes when tested at a flow rate of 100±10 liters per minute, 50±5 percent relative humidity and 25±5 ºC for each TRA

Durability Test Matrix: Environmental, Transportation and Drop Tests

•Test	•Test Method	•Test Condition	•Duration
•Hot Constant	•MIL-STD-810F, 501.4	•71 0C (160 0F), Constant	•5 Weeks
•Cold Constant	•MIL-STD-810F, 502.4	•Basic Cold, -32 0C (-24 0F), Constant	•3 Days
•Humidity	•MIL-STD-810E, 507.3	•Realistic, Natural Cycle Humidity Profiles in the U.S.	•5 Days "quick look" •Mil-Std-810E •Table 507.3-II
•Transportation •Vibration	•MIL-STD-810F, 514.5	•U. S. Roadway Vibration, Unrestrained	•12 hours/axis, 3 Axes; Total Duration = 36 hours = 12,000 miles
•Drop	•Adopted from NIOSH, CBRN APR Standard	•Height of 3 Feet	•1 Drop on each of the 3 Axes per Unit

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